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THE

PRINCIPLES

OF

FORTIFICATION;

REDUCED INTO

QUESTIONS AND ANSWERS

FOR THE USE OF

THE ROYAL MILITARY ACADEMY,

AT

WOOLWICH.

BY THE LATE

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PROFESSOR OF FORTIFICATION AND ARTILLERY.

THE SEVENTH EDITION, REVISED AND CORRECTED

BY

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ELEMENTARY FORTIFICATION.

PRELIMINARY NOTIONS.

A FORTIFICATION is represented on paper by plans, profiles, geometrical elevations, and, sometimes, by perspective elevations.

Ichnography, or the plan of a work, is its representation as it appears when cut horizontally upon the top of the foundations; it shews the length of the lines, the several angles, the length and breadth of the ditches, and the different thicknesses of earth and masonry.

Orthography, or the profile of a work, is its representation as it appears when cut perpendicularly from the highest part to the lowest; it shews the thickness, height, and depth of the several parts.

Geometrical elevations are also called orthography, when all the dimensions are observed to be in their proper proportions according to a scale.

Perspective elevation is the art of drawing buildings, fortifications, countries, towns, &c., in perspective; that is to say, with the diminutions which the rules of perspective require.

A drawing of this kind is also called scenography, in opposition to ichnography and orthography, which are rightly called geometrical, in which the rules of perspective are not observed.

THE
PRINCIPLES
OF
FORTIFICATION.

1. *What is understood by fortification?*

Fortification, taken in its most extensive signification, is the art of constructing, of attacking, and of defending places.

2. *What is the origin of fortification? or, what gave rise to the art of fortifying places?*

The origin of fortification is obviously of such remote antiquity that, it would be impossible to trace its rise and progress through the obscurity of early history; but it must have been suggested by the necessity which, single families at first, and larger communities afterwards, felt of protecting themselves and their flocks against the sudden attacks of distant tribes, excited by the thirst after plunder and wanton acts of ferocious hostilities.

3. *How is fortification divided?*

Into offensive and defensive.

4. *What is offensive fortification?*

It is the art of conducting a siege.

5. *What is defensive fortification?*

It comprehends military architecture, which is the art of securing a place by works to resist a siege.

6. *Are there not some other divisions of fortification?*

It is likewise divided into natural and artificial.

7. *What is natural fortification?*

It consists of those obstacles which naturally occur in some countries to impede the approaches of an enemy. When a place is situated upon the top of a hill, the roads to which may be easily closed up; or when surrounded with marshes, which are impassable;—such obstructions are called natural fortification.

8. *What is artificial fortification?*

It consists of such works as are constructed to defend a place.

9. *How is artificial fortification divided?*

It is divided into permanent, and field-fortification.

10. *What is permanent fortification?*

It is the art of putting towns, and other places, into a state to resist the attack of an enemy.

11. *What is field-fortification?*

It shews the method of fortifying a camp, mills, churches, country houses, and the construction of têtes-de-pont, redoubts, star-forts, and intrenchments. Works of this nature are to be considered as temporary, and they exist only in time of war.

12. *What are the principal parts of which every fortification is composed?* Fig. 2.

The rampart, ditch, and covert-way.

13. *What is the rampart?* Fig. 2.

It is an elevation of earth, and is that part of a fortification which is situated next to the town.

14. *Into what parts is the rampart divided?* Fig. 2.

The interior slope, the terre-plein, the banquette, the parapet, and the exterior slope or escarp.

15. *What is the interior slope?* Fig. 2.

It is the inclination of the earth, forming the rampart, and its declivity towards the town. The base of this slope is made once, or once and a half, the height of the rampart, according to the nature of the soil.

16. *What is the terre-plein of the rampart?* Fig. 2.

It is the upper part of the rampart, which remains after having constructed the parapet.

17. *What is the general height of a rampart?*

It is different, according to the nature of the ground surrounding the place, and the situation of the works. The height of the rampart, from the plane of site to the crest of its parapet, is from 16 to 22 feet, to command the different approaches to the town.

18. *What is the parapet?* Fig. 2.

It is a mass of earth elevated on the terre-plein of the rampart, on the side towards the country. The parapet is made from eighteen to twenty-two feet thick, according to the nature of the soil, that the shot may not penetrate it, and from six to eight feet high, to cover the troops drawn up behind it from the fire of the enemy. The top of the parapet is formed with a declivity towards the country, which is called the *superior slope.*

19. *Why is the superior part of the parapet made inclining towards the country?*

In order to discover the enemy as near as possible to the place. This slope is never made more than two inches per foot, as it would otherwise weaken too much the crest, or the interior ridge of the parapet.

20. *What is the banquette?* Fig. 2.

The step on which the soldiers stand to fire over the parapet. The breadth of its terre-plein is from 4 to 5 feet, and raised within 4½ feet of the crest of the parapet, having a slope equal to twice its height.

21. *In what manner is the earth of the rampart retained on its exterior side?* Fig. 2.

By a wall which is called a revetement; this revetement is five feet thick at the top, with a slope equal to one-sixth of its height. There are counter-forts or buttresses on its interior side, which are constructed from fifteen to eighteen feet distant from centre to centre of each other.

22. *What should be observed in the construction of the revetement?*

That its height, from the bottom of the ditch to the cordon, should not be less than 27 feet, to render the escalade difficult; and its top to be in the same plane of defilement with that of the crest of the covert-way, so as to be covered by it from the fire of the distant batteries, and, at the same time, to prevent the besiegers from reconnoitering the place.

23. *What is a rampart with half revetement?*

When the exterior side of the rampart is formed into a slope of earth, above the ground plane, or plane of site, and only that part of the escarp forming the depth of the ditch has a revetement.

24. *What is a rampart without revetement?*

When the whole exterior surface is formed into a slope of earth, or when divided into two slopes by a berm, the base of these slopes being made equal to the two-thirds of the perpendicular height of the rampart, more or less, according to the nature of the soil.

25. *What is the berm?*

It is a space or path, from three to ten feet broad, between the exterior slope of the rampart and that of the ditch.

26. *What is the use of the berm?*

To prevent the earth from falling into the ditch; and it serves, likewise, for the communication round the works.

27. *What is the cordon?* Fig. 2.

It is a round projection of stone, in a semicircular form, whose diameter is about one foot, placed on the top of the revetement of the escarp. It forms an obstacle to the besiegers, when applying ladders to the escarp for the purpose of an escalade.

28. *What is the escarp?* Fig. 2.

It is the exterior slope of the works.

29. *What is the counterscarp?* Fig. 1 and 2.

It is that slope which terminates the breadth of the ditch, and is thus called from being opposite to the escarp.

30. *What is understood by the principal, or outline?* Fig. 1.

It denotes the contour, or the line by which the first figure of the works is defined. This line is supposed to pass along the superior part of the cordon, from whence all other dimensions of a work are set off; as, for instance, the breadth of the rampart, ditch, &c.

31. *What is the exterior side?* Fig. 1.

It is a line extending from the flanked angle of one bastion to that of the next, being the side of the polygon on which the front of fortification is constructed.

32. *What is the perpendicular?* Fig. 1.

It is a line drawn perpendicularly from the point of bisection of the exterior side towards the place; its length being proportionate to the extent of the exterior side and the adjacent angles of the polygon.

33. *What is the line of defence?* Fig. 1.

It is that line which extends from the angle of the flank to the flanked angle of the next bastion.

34. *What are the faces of a work?* Fig. 1.

They are those lines which form a saliant angle projecting towards the country.

35. *What is the flank?* Fig. 1.

It is a part of a work so disposed as to defend another; and it is that line which joins the face of a bastion to the curtain.

36. *What is the curtain?* Fig. 1.

It is that part of the rampart of the body of the place, which lies between two bastions, and which joins the flanks thereof.

37. *What is an interior side?* Fig. 1.

It is a line drawn from the centre of one bastion to that of the next, or the line of the curtain produced to the two oblique radii of the front.

38. *What is the centre of a bastion?* Fig. 1.

It is the intersection made by the two demi-gorges.

39. *What is the demi-gorge of a bastion?* Fig. 1.

It is the line which is formed by the prolongation of the curtain meeting the oblique radius.

40. *What is the right radius?* Fig. 1.

It is a line drawn from the centre of the polygon, perpendicular to the exterior side.

41. *What is the oblique radius?* Fig. 1.

It is a line drawn from the centre of the polygon to the extremity of the exterior side.

42. *What is the exterior, or great radius?* Fig. 1.
It consists of the whole oblique radius.

43. *What is the interior, or small radius?* Fig. 1.
It is that part of the oblique radius which extends from the centre of the polygon to the centre of the bastion.

44. *What is the capital?*
It is a line drawn bisecting the saliant angle of a work.

45. *What is meant by the angle at the circumference of the polygon?* Fig. 1.
It is that angle which is formed by the meeting of the two sides of the polygon.

46. *What is the angle at the centre of the polygon?* Fig. 1.
It is the angle formed by two oblique radii.

47. *What is the flanked angle?* Fig. 1.
This angle is formed by the meeting of two faces of a work, which angle is saliant towards the country.

48. *What is the angle of the shoulder?* Fig. 1.

It is the angle formed by the face and the flank of a bastion.

49. *What is the angle of the flank?* Fig. 1.

It is formed by the meeting of the flank and the curtain.

50. *What is the diminished angle?* Fig. 1.

It is formed by the exterior side and the line of defence.

51. *What is the flanking angle; or angle of the tenaille?* Fig. 1.

It is the exterior angle, formed by the intersection of the two lines of defence.

52. *What is the interior flanking angle?* Fig. 1.

It is formed by the line of defence, and the curtain.

53. *What is the re-entering angle of the counterscarp?* Fig. 1.

It is formed by the intersection of the two lines of the counterscarp, opposite the curtain.

54. *What is meant by a front of fortification?*

It is a portion of the body of the place, consisting of two half bastions and a curtain.

55. *What is a fausse-bray?*

It is a second enclosure of the body of the place, joining the first by a terre-plein, of 3 or 4 toises, taken on the plane of site, or sometimes 2 or 3 feet above it, having a parapet of 3 toises thick.

56. *What is the use of the fausse-bray?*

To augment the defence of the place, by obtaining a close and grazing fire for the ditch, and upon the covert-way. But as the faces and flanks of this work were exposed to be enfiladed, and the escalade rendered easy by it, this second enclosure of the body of the place has been omitted in the late systems.

57. *What is an epaulement?*

It is an elevation of earth thrown up, to cover troops in flank from the fire of the enemy.

58. *What is the ditch?* Fig. 3 and 4.

It is an excavation from 12 to 24 feet deep, and from 15 to 25 toises broad, surrounding the rampart. The side of the ditch next the place forms part of the escarp; and the opposite part next the country, called the counterscarp, is made circular opposite to the saliant angles of the works.

59. *What is the use of the ditch?*

By increasing the height of the escarp, it serves to prevent a surprise, and adds to the difficulty of taking the place.

60. *How many kinds of ditches are there?*

Wet ditches, dry ditches, and others which are dry, but may be made wet when occasion requires.

61. *What are the advantages, or disadvantages, of a wet ditch?*

It is the best for preventing a surprise; but the quantity of bridges of communication which require continual repairs in time of a siege, and the difficulty of making sallies, render this kind of ditch inconvenient.

62. *Is a dry ditch preferable?*

Yes; for it can with facility be repaired, sallies may easily be made, and it is capable of containing many works proper for its defence.

63. *What advantage has the third sort of ditch?*

It has all the advantages of the other two kinds, as it may be made wet or dry occasionally; and it is, therefore, to be preferred to either of them, whenever it can be carried into execution.

64. *What is the covert-way?* Fig. 3 and 4.

It is a space of 5 toises broad, extending round the counterscarp of the ditch, and covered by a parapet from 7 to 9 feet high, having a banquette; the superior part of this parapet forms a gentle slope towards the country, which terminates at the distance from 20 to 35 toises; this slope is called the *glacis.*

65. *Of what advantage is the covert-way to the place?*

It serves to draw up troops for making sallies, which are likewise supported from the covert-way, and this work costs less than any other in proportion to the difficulty of taking it.

66. *What are the places-of-arms of the covert-way?* Fig. 3 and 4.

They are spaces contrived in the saliant and re-entering angles of the covert-way. The saliant places-of-arms are formed by the circular part of the counter-scarp, and by the prolongation of the branches of the covert-way, till they intersect. The re-entering places of arms are constructed with two faces forming a saliant angle, and drawn at an inclination of 100 degrees with the covert way. The demi-gorges of the re-entering places of arms are generally from 10 to 12 toises; and when they are to contain a redoubt or an intrenchment, they are from 20 to 24 toises.

67. *Of what use are the places-of-arms in the covert-way?*

The re-entering places-of-arms are to flank the branches of the covert-way, and to contain the troops for its defence. The saliant places-of-arms also serve for assembling the troops destined for the defence of the covert-way.

68. *What are the sally-ports*[*] *in the covert-way?* Fig. 3 and 4.

They are openings cut in the glacis, at the faces of the re-entering places-of-arms, and at the branches of the covert-way, of 12 feet wide, and from 16 to 20 feet long, forming a ramp from the bottom of the slope of the banquette to the surface of the glacis, and shut by a gate. Their use is to facilitate the sallies made from the covert-way.

69. *What is the redoubt in the re-entering place-of-arms?* Pl. 3.

It consists of two faces 18 toises in length, and of two demi-gorges of 20 toises, taken from the re-entering angle of the counterscarp. The thickness of its parapet is 12 feet, and has a command of 4 feet upon the crest of the glacis, having a ditch of 15 feet wide, and 8 feet deep; the top of its revetement is on a level with the crest of the glacis.

70. *What is the use of the redoubt in the re-entering places-of-arms?*

To increase the defence of the branches of the covert-way; to protect the sallies, and to assure them a safe retreat by ramps made in the ditch of the redoubt, leading to posterns constructed at the extremities of its faces, close to the revetement of the counterscarp of the ditch of the body of the place.

71. *What are the traverses in the covert-way?* Fig. 3 and 4.

They are parapets which cross the breadth of the covert-way at the saliant and re-entering places of arms. Other traverses are also constructed in the branches between two places-of-arms, so as the distance from the centre of one traverse to that of another should not exceed about 18 toises.

72. *What is the use of the traverses?*

They are to cover the troops drawn up behind the parapet of the covert-way, from the enfilade fire of the enemy.

73. *What are the passages of the traverses?*

They are openings cut into the parapet of the covert-way close to the traverses, of about six feet wide, in order to form a communication from one part of the covert-way to another; these passages are shut by a gate when occasion requires.

74. *What are the advantages of the glacis?*

The slope of the glacis forming a gentle declivity towards the country, its parapet cannot be ruined by the besiegers' batteries, and it covers the revetement of the body of the place; at the same time being an inclined plane, it is well seen and defended from the several works of the body of the place.

75. *What is the advanced ditch?* Pl. 3.

It is formed by producing the superior slope of the glacis.

76. *What is the advanced covert-way?* Pl. 3.

When an advanced ditch is constructed, there is also an advanced covert-way, parallel to that of the body of the place, which last has a command upon the former of 2 or 3 feet, according to the nature of the ground.

77. *What is the use of the advanced covert-way?*

It has the same advantages as that of the body of the place; and by extending so far into the country, it serves to keep the enemy at a distance, and renders his approaches more difficult: it also considerably augments the strength of a place; because, after the enemy has taken it, he has still the usual obstacles to overcome.

78. *What is termed the body of the place?*

The works immediately next to, and surrounding, the town, in the form of a polygon, whether regular or irregular, and composed of bastions joined by curtains.

79. *What are bastions?* Fig. 1.

They are works saliant from the place, composed of two faces and two flanks, and connected by curtains.

80. *Why are bastions constructed saliant, and with flanks?*

In order that the whole escarp may be discovered from some part or other of the body of the place, and that a reciprocal defence may be obtained.

81. *What are the different kinds of bastions?*

Full bastions, empty bastions, bastions with orillons, flat bastions, detached bastions, demi-bastions, and tower-bastions.

82. *What is a full bastion?* Fig. 4.

When the terre-plein, or body of the rampart, occupies all the interior space of the bastion.

83. *What is an empty bastion?* Fig. 4.

When the terre-plein and interior slope of the rampart is parallel to the faces and flanks, and consequently leaves an empty space towards the centre.

84. *What is a bastion with orillons?*

When the faces are produced at the angle of the shoulder, in the form of a semi-circle, occupying about seven toises of the flanks, and the rest of which is made concave.

85. *What is the reverse of the orillon?* Fig 4.

It is a line 5 toises in length, joining the orillon to one extremity of the concave flank. There is generally a passage made through the reverse of the orillon, at the bottom of the ditch: this passage is called a sally-port, or postern.

86. *What is the brisure of the curtain?* Fig. 4.

It is the prolongation of the line of defence from the angle of the flank, towards the capital of the bastion; this prolongation is five toises in length, and joins the extremity of the concave, or retired flank, opposite to the reverse of the orillon.

87. *What are the advantages and disadvantuges of bastions with orillons and conclave flanks?*

The orillon covers the flank and conceals a gun placed in the direction of its reverse, which may see the breach of the collateral bastion, without being itself exposed to be dismounted otherwise than by shells. The flank gives a converging fire for the defence of the passage of the ditch, and the breach of the opposite bastion. It contains, by its convexity, more guns and a greater space for working them, than if the flank was in a straight line. But when the defence is made by small arms, the men towards the reverse of the orillon, performing their fire as usual perpendicular to the parapet, will fire upon the curtain and upon the opposite flank; and those towards the brisure of the curtain, will fire upon the re-entering place-of-arms and into the ravelin.

88. *What is a flat bastion?*

It is that which is constructed upon a right line, and whose demi-gorges do not form an angle.

89. *What is a detached bastion?*

It is that which is separated by a ditch from the body of the place; such as the counterguards with flanks, constructed by Vauban in his second and third systems, to cover the tower bastion.

90. *What is a demi-bastion?* Fig. 3 and 4.

It is that which has one face and one flank, cut off by the capital; they terminate the head of a horn, or crown-work.

91. *What is a tower bastion?*

It is a small bastion, constructed by Vauban in his second and third systems. The top or platform of the tower-bastion is four feet higher than the terre-plein of the rampart of the curtain: underneath its platform are casemates, to contain four pieces of cannon, two in each flank.

92. *Are large bastions to be preferred to small bastions?*

Large bastions with good revetements are best; because they contain more troops, cannon, and mortars, than the small bastions: the enemy always attack the bastion, as being the weakest part of the body of the place; but when it is well intrenched, this defect is in a great measure obviated.

93. *Are intrenchments in a bastion advantageous to the place?*

They are so essential in a besieged place, that without them the proper resistance cannot be made against an assault.

94. *In what kind of bastions can the best intrenchments be constructed?* Fig. 3.

Full bastions are preferable for being intrenched by a work, consisting of a parapet and a ditch; forming either a re-entering angle, or a small front of fortification. A cavalier, whose faces being separated from those of the bastion by a ditch, and coupures made towards its shoulders, may also be considered as an intrenchment.

95. *What is their use?*

To prolong the defence of a place.

96. *What is a cavalier?* Pl. 3.

It is a work constructed upon the terre-plein of the bastion, whose faces and flanks are made parallel to those of the bastion, but sometimes in form of a horse-shoe; its terre-plein is elevated from eight to twelve feet above that of the rampart, having a parapet of eighteen feet thick and six high. Cavaliers, in form of a horse-shoe, are sometimes constructed upon the terre-plein of the curtain.

97. *What is the use of the cavalier?*

To command some rising ground within cannon-shot, and by its elevation to serve as a traverse for preventing the neighbouring curtains from being enfiladed, and the flanks of the bastion from the reverse fire of the besieger's batteries.

98. *What is a citadel?*

It is a fortress joined to the works of a place, and is fortified as well towards the town as towards the country. A citadel should be always situated on the most commanding ground, and it serves to keep the inhabitants in awe; and should the town be taken, it becomes a retreat for the garrison.

99. *What is an esplanade?*

It is a space of even ground, clear of buildings, situated between the town and the citadel, so that no one may approach it thence unperceived.

100. *What is understood by out-works?*

They are works constructed beyond the body of the place; such as tenailles, ravelins, counterguards, horn-works, crown-works, lunettes, tenaillons, bonnets, detached redoubts, detached lunettes, and fleches, or arrows.

101. *What is a tenaille?* Fig. 3 and 4.

It is a work constructed upon the lines of defence, before the curtain; composed of two faces and a small curtain. The relief or elevation of the tenaille is determined by a defilement relative to the height of the neighbouring flanks of the bastions. It has a parapet from 7 to 7½ feet high, and from 12 to 15 feet thick.

102. *What is the use of the tenaille?*

To cover the postern in the curtain and the flanks, to protect the troops drawn up behind it in readiness to sally upon the passage of the ditch, and serves to augment the defence of the ditch: the fire from this work is more effectual than that from the flanks, being more horizontal and nearer.

103. *What is a ravelin, or demi-lune?* Fig. 3 & 4.

It is a work constructed opposite the curtain, composed of two faces which form a saliant angle towards the country, and two demi-gorges formed by the counterscarp.

104. *What is the use of the ravelin?*

To cover the curtain, the gates, and the flanks of the bastions.

105. *What is the redoubt in the ravelin?* Pl. 3.

It is a work, whose faces are parallel to those of the ravelin, at the distance of 15 or 16 toises; it has flanks of seven or eight toises, to contain two pieces of cannon, to fire into the breach of the collateral bastions. And the redoubt further serves as a retreat for the troops which defend the ravelin; also to check the enemy, should they endeavour to establish themselves there.

106. *What is a counterguard?* Pl. 3.

It is a work composed of two faces forming a saliant angle, and constructed before the flanked angle of a bastion; the faces of which it covers, as also the flanks of the collateral bastions; so that the enemy cannot batter them without being first master of this work.

107. *What is a horn-work?* Fig. 3.

It is a work composed of two half-bastions and a curtain, with two long sides, called branches, or wings, directed upon the faces of the bastions, or ravelins, so as to be defended from them. This work is placed before a bastion, or before a curtain, and serves to enclose any buildings which could not be brought within the body of the place, or to occupy a piece of ground which might be of advantage to the enemy.

108. *What is a crown-work?* Fig. 4.

It is a work composed of a bastion between two curtains, which are terminated by half-bastions. This work is joined to the body of the place by two long sides, and is placed either before a curtain, or before bastions, which should command and enfilade the branches. The crown-work is adopted for the same purposes as the horn-work.

109. *As horn and crown-works may be constructed, either before a bastion, or before a curtain; which of these two situations should be preferred?*

Before the bastion, because the besieger can only batter the faces of the collateral ravelins through the openings of the ditch of the branches. But when situated before a ravelin, the besieger will be able to batter the faces of the bastions, upon which the branches of the horn or crown-work are directed; and after having taken the work, he may proceed with more facility towards the breaches already made in the body of the place.

110. *What are lunettes?* Pl. 3.

They are works constructed on each side of the ravelin, one face being perpendicular to that of the ravelin, taken at one-half, or one-third from the flanked angle, and the other face nearly perpendicular to that of the bastion.

111. *What are tenaillons?* Pl. 3.

They are works constructed on each side of the ravelin, nearly similar to the lunettes, differing only in this respect, that one of the faces of the tenaillon is that formed by producing the face of the ravelin, the other face is directed to the face of the bastion in the same manner as the lunettes.

112. *What is a bonnet?* Pl. 3.

It is a work constructed between the lunettes, to cover the flanked angle of a ravelin; it consists of two faces, which are defended from those of the lunettes.

113. *What is a detached redoubt?* Pl. 3.

It is a small enclosed work situated beyond the glacis. It serves to occupy some particular spot of ground, that might prove of advantage to an enemy, or placed between two works to connect their defences, and to preserve the communication between them.

This work, when of an irregular form, is called a *patee.*

114. *What is a detached lunette?* Pl. 3.

It is a kind of small ravelin, whose faces are from 25 to 30 toises, having flanks of about 8 or 9 toises, constructed beyond the advanced ditch, upon the capitals of the works of the body of the place, and upon those of the ravelins.

115. *What is a fleche, or arrow?* Pl. 3.

It is a work constructed along the foot of the glacis, before the re-entering and saliant places of arms: it consists only of a parapet, which forms a saliant angle; its faces are from 20 to 25 toises, and its height from 7 to 8 feet: this work has a communication with the covert-way cut through the glacis.

116. *What is the caponniere?* Pl. 3.

It is a passage across the ditch, from the tenaille to the gorge of the ravelin, of 30 feet wide, and covered on each side by a parapet, from 6 to 8 feet high; its superior slope terminating in a glacis of 10 or 12 toises. The passage cut through the glacis to communicate from the covert-way to a detached work is likewise called a caponniere.

117. *What is the traverse, or half caponniere in the ditch?* Pl. 3.

It is a work constructed in the dry ditch of a ravelin, to augment its defence. It consists of a parapet, which is perpendicular to the face of the ravelin, of 6 to 8 feet high, and its superior slope is formed into a glacis, as that of the caponniere.

118. *What is the cunette, or cuvette?* Pl. 3.

It is a small ditch, from four to eight feet broad, made in the middle of a dry ditch, to drain off the water from the place. When there is a cunette, there should be a caponniere to flank it.

119. *What is a batardeau?* Pl. 3.

It is a solid piece of masonry of seven or eight feet thick, which crosses the whole breadth of the ditch, opposite the flanked angles of the bastions, upon the line of the capital produced; the top of the batardeau ought not to be more than four feet above the surface of the water: it terminates in a ridge, or roof, upon the middle of which is constructed a round turret, of six or seven feet in diameter, and about five feet higher than the batardeau, with a conical top.

120. *What is the use of the batardeau?* Pl. 3.

To retain the water in those parts of the ditch required to be inundated.

121. *What is a ramp?* Pl. 3.

It is a road cut obliquely in the interior slope of the rampart, as a communication from the town to the terre-plein.

122. *What is a postern, or sally port?*

It is a passage constructed under the rampart, which serves to communicate from the town into the ditch.

123. *What communication is there from the ditch into the covert-way?* Fig. 3 and 4.

By stairs, called pas-de-souris, made in the circular parts, and in the re-entering angles of the counterscarp.

124. *In what manner is the communication formed from the town into the country?*

A gateway is constructed in the middle of the curtain, with a bridge extending to the outworks, and from the outworks to the covert-way; each bridge has a part of it contrived to draw up when required; passages are formed in the line of the communication through the ramparts of the outworks, and from the covert-way through the glacis.

125. *What is a portcullis?*

It is an ancient contrivance, consisting of a sliding frame of timber or iron, in the shape of a harrow, hung over the gate, to be let down when the outer gate is forced. Separate beams of wood hung vertically, and called *orgues*, were also used for the same purpose; but both these contrivances requiring lofty buildings, which are too conspicuous in the reconnoitering of places, they have been laid aside, and strong gates are adopted instead.

126. *What are barbet batteries?* Fig. 4.

They are platforms elevated behind a parapet or breast-work, within about two feet and a half of its crest, from which the cannon fire over the parapet. These batteries are generally erected at the flanked angles of the several works.

127. *How are the batteries in the flanks of the bastions constructed?*

The platforms are not made higher than the terre-plein, and there are openings cut in the parapet, which are called embrasures, for the cannon to fire through:

the part of the parapet which remains between two embrasures, is called a merlon.

128. *Is there not sometimes a battery constructed in the curtain, to defend the face of the bastion?*

When the face of the bastion can be discovered from a part of the curtain, which is then called an oblique or second flank, a battery is there constructed.

129. *Are not batteries sometimes constructed under those of the rampart of the flanks?*

Some flanks have casemates, or vaulted batteries, formed in them, which are bomb-proof, and the embrasures for the guns are cut through the revetement: the particular use of these batteries is to defend the passage of the ditch.

130. *What are loop-holed galleries?*

They are casemates constructed behind the revetement of the counterscarp, and behind that of the gorges of detached out-works, having loopholes to defend the ditch by a reverse fire of small arms.

131. *What is a mortar battery?*

It consists of a breast-work without embrasures, of 8 feet high, and from 18 to 22 feet thick.

132. *What is the genouillere?*

It is the interior elevation of the parapet which remains above the platform, after having made the opening of the embrasure; it covers the lower part of the carriage. The height of the genouillere from the platform is regulated according to the nature of the gun; from 2 to 3 feet.

133. *What is a platform?*

It is a floor of wood, stone, or other materials, on which cannon are placed: its length is from 18 to 20 feet; its breadth close to the breast-work, 8 feet; and behind, from 14 to 15 feet, having a declivity of one inch to every yard towards the parapet, to prevent too great a recoil of the piece.

134. *What are the loopholes?*

They are oblong holes, from 15 to 18 inches long, 6 inches wide within, and 2 or 3 inches without, cut through masonry or timber, for the service of small arms.

135. *What are the palisades?*

They are stakes of strong wood, from 8 to 9 feet long, and 6 inches broad, fixed about three feet deep into the ground, and about 3 or 4 inches asunder: they are placed in a row in the covert-way, close to the parapet: palisades are also placed upon the berm of a rampart with half revetement, or in the middle of dry ditches.

136. *What is their use?*

To prevent the garrison from being surprised.

137. *What are the fraises?*

They are a kind of palisades placed horizontally in the exterior slope of ramparts with half revetements on the level of the terre-plein produced; and when without revetement, there should be a second row of fraises fixed at the distance of 8 or 9 feet above the bottom of the ditch.

138. *What are the chevaux-de-frize?*

They consist of a piece of timber, either round, or cut into several faces, from 9 to 12 feet long, and from 5 to 6 inches in diameter; into which are inserted staves cross-wise of about 2 inches thick, and 6 feet long, pointed at the ends, if made in a hurry in the field; but shod with iron when made beforehand. Their use is for defending a passage, stopping up a breach, or to form an intrenchment against cavalry.

139. *What are trous-de-loup?*

They are holes made in the form of an inverted cone, of about 6 feet deep, and about 4½ feet in diameter at the top. They are sometimes made at the foot of the glacis of detached out-works beyond the glacis of the advanced covert-way.

140. *What are fascines?*

They are composed of branches made up in the form of fagots, of 6 feet long and 8 inches in diameter, tied in two or three places. They are used for retaining the earth of parapets.

141. *What are saucissons?*

They are fascines from 18 to 20 feet long, and from 10 to 12 inches in diameter; they are used to keep up the earth in erecting the breast-work of a gun or mortar battery.

142. *What are gabions?*

They are cylindrical baskets, without a bottom, from 3 to 4 feet high, and the same in diameter, filled with earth. They are used for intrenchments in the defence of places.

143. *What are sand-bags?*

They are bags from 10 to 15 inches in diameter, and from 20 to 30 inches high, filled with earth or sand, to repair breaches, and the embrasures, when damaged by the enemy's fire: there is also a smaller sort made of 9 inches in diameter, and 18 inches long, placed three together, upon the top of the parapet, leaving a small opening between them, for the men to fire through.

144. *How is the First System of Mr. de Vauban divided?*

Into three; viz: the little, mean, and great fortification. The exterior side of the little fortification is from 120 to 175 toises; the mean, from 175 to 185; and the great, from 185 to 260.

145. *In what case is the little fortification adopted?*

It is used in the construction of citadels and forts of four or five sides, also in horn and crown-works.

146. *In what case is the mean fortification meployed?*

For all sorts of towns.

147. *On what occasion is the great fortification made use of?*

It is never adopted for all the sides of a place; but only for a long side, towards a river or a marsh.

148. *What dimensions are usually given to small forts?*

The exterior side is from 60 to 120 toises; the perpendicular, in the square, is equal to $\frac{1}{8}$, that in the pentagon equal to $\frac{1}{7}$, and the faces of the bastions in both equal to $\frac{2}{7}$, of the exterior side.

149. *What is the length given to the faces of bastions?*

From thirty-five to sixty toises.

150. *What length is given to the flanks?*

Such a length as the besieger can give to his counter-batteries to batter them, which must be equal to the breadth of the ditch and that of the covert-way, at the flanked angle of the bastion opposite to the flank; for example, should the breadth of the ditch be 15 toises and that of the covert-way 5 toises, the length of the flank ought to be 20 toises.

151. *What is the best position for all flanks, with respect to the line of defence?*

When perpendicular to it.

152. *What is the least opening admitted in the formation of the flanked angles?*

Sixty degrees: for if less they would easily be destroyed by the besieger's batteries, and their interior part would not afford a sufficient space in the defence. The best flanked angles are those which are obtuse, as their faces cannot be so easily enfiladed by the ricochet batteries.

153. *What is a dead angle?*

A re-entering angle is said to be a dead angle, when it cannot be seen or defended from any part of the works.

154. *What is the length of the curtain?*

From 70 to 80 toises.

155. *What is to be done if the curtain should be too long?*

A flat bastion, called a moineau, should be constructed in the middle of the curtain: sometimes it is separated by a ditch, and is then called a detached bastion: this work is not raised so high as the rest of the place.

156. *In what manner is the length of the curtain to be determined, the height of the flanks being given?*

By the following proportion: as the perpendicular depression of the superior slope of the parapet of the flank is to its horizontal thickness, so is the height of the rampart, including the parapet, to the distance of half the curtain, which being doubled, will give the whole length of the curtain; and in the same manner the height of the flanks may be determined, when the length of the curtain is given.

157. *What is the length of the line of defence?*

From 120 to 140, or at most 150 toises.

158. *What is the difference between the line of defence razant or grazing, and the line of defence fishant or plonging?*

The line of defence razant is when the face of the bastion produced meets the angle of the flank: the line of defence fishant is, when the face of the bastion produced falls on some part of the curtain. In the first case, the fire from the flank grazes the faces of the bastion to be defended; and in the latter construction, that fire forms an acute angle with the face of the bastion, and, therefore becomes plonging.

159. *What is understood by a direct fire or defence?*

When the line of fire is perpendicular to the parapet.

160. *What is termed an oblique fire, or defence?*

When the line of fire is oblique to the parapet.

161. *In placing a battery, is the oblique or the direct fire to be preferred?*

The direct or perpendicular fire is preferred: and for this purpose the battery should be placed parallel to the object against which its fire is required. This rule should particularly be observed with regard to parapets intended for musketry, as the soldiers are apt to fire directly before them without taking aim.

162. *What is meant by a command?*

It is the vertical elevation of one work above another, or above the country. When the height of the rampart including that of its parapet is 20 feet, and that of the parapet of the covert-way 9 feet above the plane of site, the rampart will have a command of 20 feet upon the country, and 11 feet upon the crest of the parapet of the covert-way, and the latter a command of 9 feet upon the field.

163. *How are the several commands distinguished?*

There are three sorts; a command in front, in the rear, and by enfilade.

164. *What is a command in front?*

When any eminence is directly facing the work whcih it commands, it is said to be a command in front.

165. *What is a command in the rear?*

When any eminence is directly behind the work which it commands, it is called a command in the rear, or in reverse.

166. *What is a command by enfilade?*

When an eminence is situated in the prolongation of any line of a work, and a considerable part of it may be seen from thence, that line is said to be subject to a command by enfilade; and such a command is the most dangerous.

167. *How are the effects of a command by enfilade to be prevented?*

By raising the saliant angles of the works exposed to such a command, or by erecting traverses at proper distances.

168. *What is the plane of site?*

It is the surface of the ground on which the works of fortification stand; it is supposed to be an even plane passing through the surface of the covert-way, which is either horizontal or inclined to the horizon;

in the latter case, when produced 800 or 900 toises into the country, so as to graze the ground without cutting off any part of its surface.

169. *What is meant by defilement?*

It is the art of disposing all the works of a fortress in such a manner that they may be under the command of the body of the place. It also includes the relative disposition of the works, and the ground within cannon-shot, so that the one may be discovered, and the other not seen into.

170. *What is meant by planes of defilement?*

They are supposed even planes passing through the crests of the parapets and parallel to the plane of site.

171. *What is understood by a plan of comparison?*

It is a geometrical plan of a fortress and the country surrounding it within cannon-shot; on which is expressed the different levels of every principal point: this plan is also called a horizontal or level plan, and it serves to regulate the defilement of a place.

172. *What is understood by fortifying inwards?*

It is when the outline of a front is constructed on the exterior side, and falls within the polygon.

173. *What is meant by fortifying outwards?*

It is when the principal or outline of a front is contructed on the interior side, and falls without the polygon.

174. *What length is to be given to the perpendicular and faces of a square?*

The perpendicular is equal to one-eighth, and the faces to two-sevenths of the exterior side.

175. *What length is to be given to the perpendicular and faces of the pentagon?*

The perpendicular is one-seventh, and the faces two-sevenths of the exterior side.

176. *May not the square and the pentagon be fortified outwards?*

Yes; and in this case the demi-gorges are made equal to one-fifth, and the capitals of the bastion equal to one-third of the interior side.

177. *What length is to be given to the perpendicular and faces of polygons of more than five sides?*

The perpendicular is equal to one-sixth, and the faces are equal to two-sevenths of the exterior side.

178. *What effects are produced in the lines and*

angles of a front by lengthening or shortening the perpendicular?

By lengthening the perpendicular, the flanked angles are diminished; and by shortening it, those angles are increased. When the exterior side exceeds 185 toises, the perpendicular must be shorter than the general proportion of one-sixth; otherwise the ditch would be too wide, and the flanks too long. Besides, if the angle of the polygon should be less than 100 degrees, the flanked angle would become too acute.

179. *What is meant by irregular fortification?*

It is the art of fortifying a place of an irregular figure, situated where the country does not admit of giving to the several works their due proportions according to rule; and sometimes irregular fortification is applied to places surrounded by ancient walls and towers.

180. *How many cases are there of irregular fortification?*

First, when the angles of the polygon are not equally distant from the centre; secondly, when some of the angles are too acute, and others re-entering; thirdly, when some of the sides are too long, and some of them too short; and lastly, when both angles and sides are irregular.

181. *What are the principal rules to be observed in irregular fortification?*

If an irregular place cannot be reduced to a regular figure, still the rules of regular fortification should, as much as possible, be observed; that is to say, the flanked angles should not be less than 60 degrees, the lines of defence should not exceed musket-shot; the sides should be lengthened or shortened, so as to obtain a sufficient space for a well proportioned front upon each; and the length of the curtains should correspond with the height of their collateral flanks.

182. *What are the two general methods of fortifying irregular places?*

After an irregular place has been reduced into the form of a polygon, parallel lines are drawn at about fifteen toises distant from the houses, to give a sufficient space for the rampart; these lines form the interior polygon, which may be fortified outwards, by setting off the demi-gorges of the bastions, and raising their flanks at an angle of 100 degrees with the curtain; or the exterior side may be found and fortified inwards.

183. *How is the exterior side to be found, the interior being given?*

By tables calculated for this purpose, or by a general method, which is, to draw a parallel to each of the interior sides. If the adjacent angle is that of a square, the distance of the parallel should be forty toises: if the angle is that of a pentagon, the distance is to be forty-five toises; and when the angle is that of a polygon of more than five sides, fifty toises should be the distance from the interior to the exterior side.

184. *Which of the two methods of fortifying, outwards or inwards, ought to be preferred?*

If the ground surrounding the place is on a level with the plane of site, it will be indifferent to use either of the two methods; but this being seldom the case, the methods of fortifying inwards is to be preferred. For example, should there be a hollow at the distance of 90 or 100 toises, it will be necessary to carry forward the saliant angles of the bastions, so as to command that part of the ground, which otherwise would favour the attack.

185. *How is an irregular place fortified, whose length considerably exceeds its breadth?*

By describing an oval about it, which may be done by drawing a line lengthways through the middle of the place; and having found by measurement the number of sides best suited to its general figure, if a heptagon, hexagon, or pentagon, 75, 77, or 80 toises are to be added to each end of this line, upon which an oval is then to be constructed for containing the polygon required: 70 toises only are to be added for polygons of more than seven sides.

186. *How is a long side of* 185 *to* 260 *toises to be fortified?*

The perpendicular is to be diminished from 30 to 20 toises, and the faces of the bastion should then be from 50 to 60 toises.

187. *How is a long side from* 280 *to* 340 *toises to be fortified?*

From the extremities of the given side as centres, and with a length of 180 toises, two acres are described, intersecting each other towards the country; by which means the given long side may be covered by two fronts.

188. *How is a long side from* 360 *to* 520 *toises to be fortified?*

It should be divided into as many parts, from 175 to 185 toises each, as the ground and other circumstances will permit: and it may then be fortified by flat bastions.

189. *How is a re-entering acute angle to be fortified?*

If the angle exceeds 60 degrees at the extremities of its two sides, bastions should be constructed, whose faces are to be defended from the sides of the re-entering angle; but if it should be less than 60 degrees, the space included between its sides should be shut up by a right line, or the two adjacent sides should be produced till they meet.

190. *How is a re-entering obtuse angle to be fortified?*

By a platform; or if the angle should be very obtuse, by a flat bastion.

191. *How is a short interior side from* 100 *to* 115 *toises to be fortified?*

By subtracting from the given side the length the curtain ought to have, and half the remainder will be for each demi-gorge of the collateral bastions.

192. *How is a place to be fortified having a river running through it?*

The polygon surrounding the place should be so disposed that the river may pass through the middle of a curtain. If the river should be as broad as the curtain is long, piles, or other obstacles, are to be placed in it, leaving only a passage for boats or vessels, which can be occasionally shut up by a boom or chain. Batteries also, should be constructed on each side to defend the passage by a cross-fire.

193. *How is a place to be fortified which is situated upon a hill?*

Exclusive of the fortification immediately surrounding the town, such advanced works must be constructed as may be requisite to command the approach to the place, and to see into any hollows that cannot be discovered from thence : these detached works must be so disposed as to be properly defended from some part of the body of the place.

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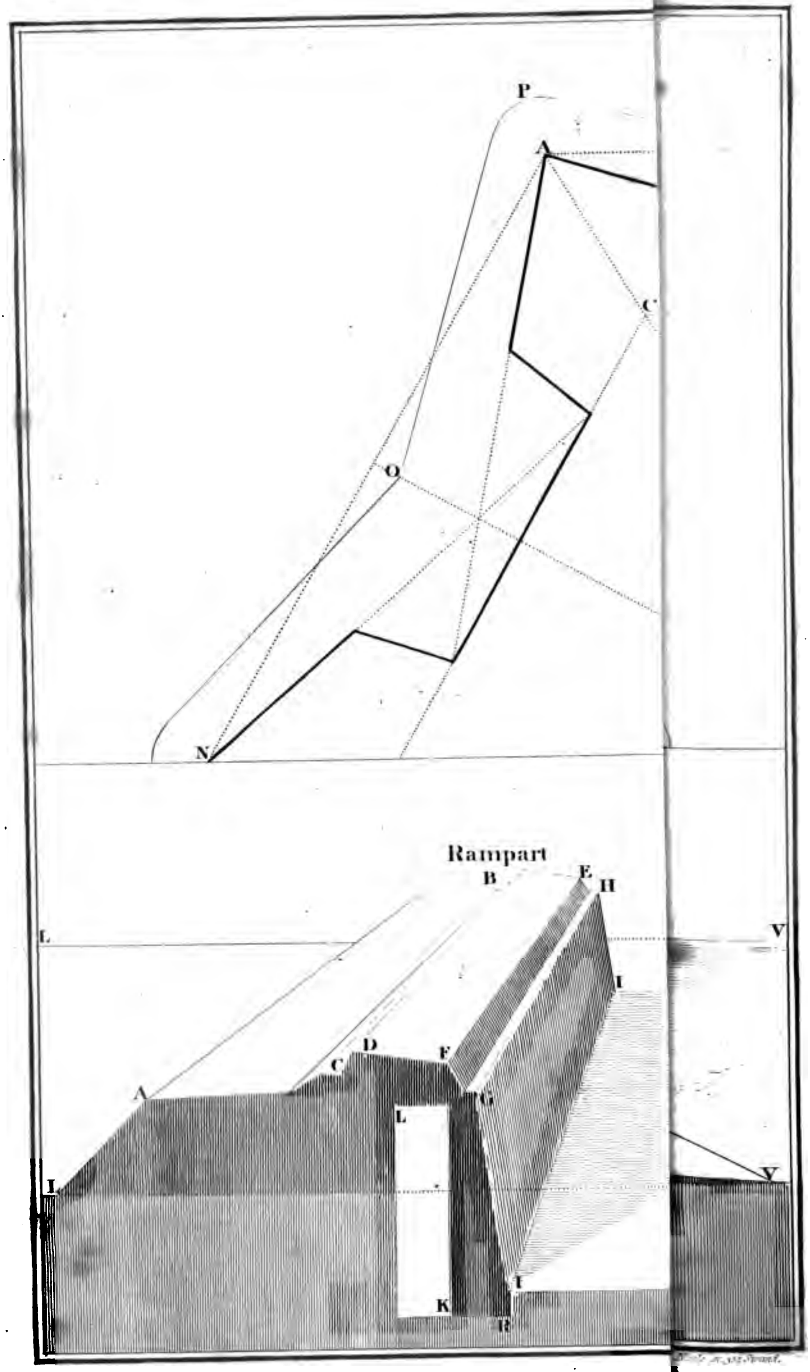
Pl. I.



Names of the Lines and Angles of a Front of Fortification, Fig. 1, Pl. 1.

A B	Exterior side.
C D	Interior side.
T A	Oblique radius.
T E	Right radius.
T C	Interior, or small radius.
T A	Exterior, or great radius.
E F	Perpendicular.
G B	Line of Defence.
A I	Face.
G I	Flank.
A C	Capital.
C G	Demi-gorge.
G H	Curtain.
H K B L M	Outline of the bastion.
A I G H K B	Principle, or outline.
O P Q R	Counterscarp.
C	Centre of the bastion.
A T B	Angle at the centre of the polygon.
N A B	Angle at the circumference of the polygon.
K B L	Flanked Angle.
A I G	Angle of the shoulder.
I G H	Angle of the flank.
A F B	Angle of the tenaille, or flanking angle.
E A F	Diminished angle.
G H I	Interior flanking angle.
P Q R	Re-entering angle of the counterscarp.

Explanation of Fig. 2, Pl. 1.

L V	Ground line, or line of site.
L H	Rampart.
A L	Interior slope of the rampart.
A B	Terre-plein of the rampart.
C	Banquett
D E	Parapet.
D F	Superior slope of the parapet.
G H	Cordon.
G I	Exterior slope of the rampart or escarp.
G K	Revetement.
K L	Counter-fort, or buttress.
I	Set-off, lessening, or retreat.
I R	Foundation of the revetement.
I N	Bottom of the ditch.
M N	Counterscarp.
M O	Terre-plein of the covert-way.
P Q	Glacis.

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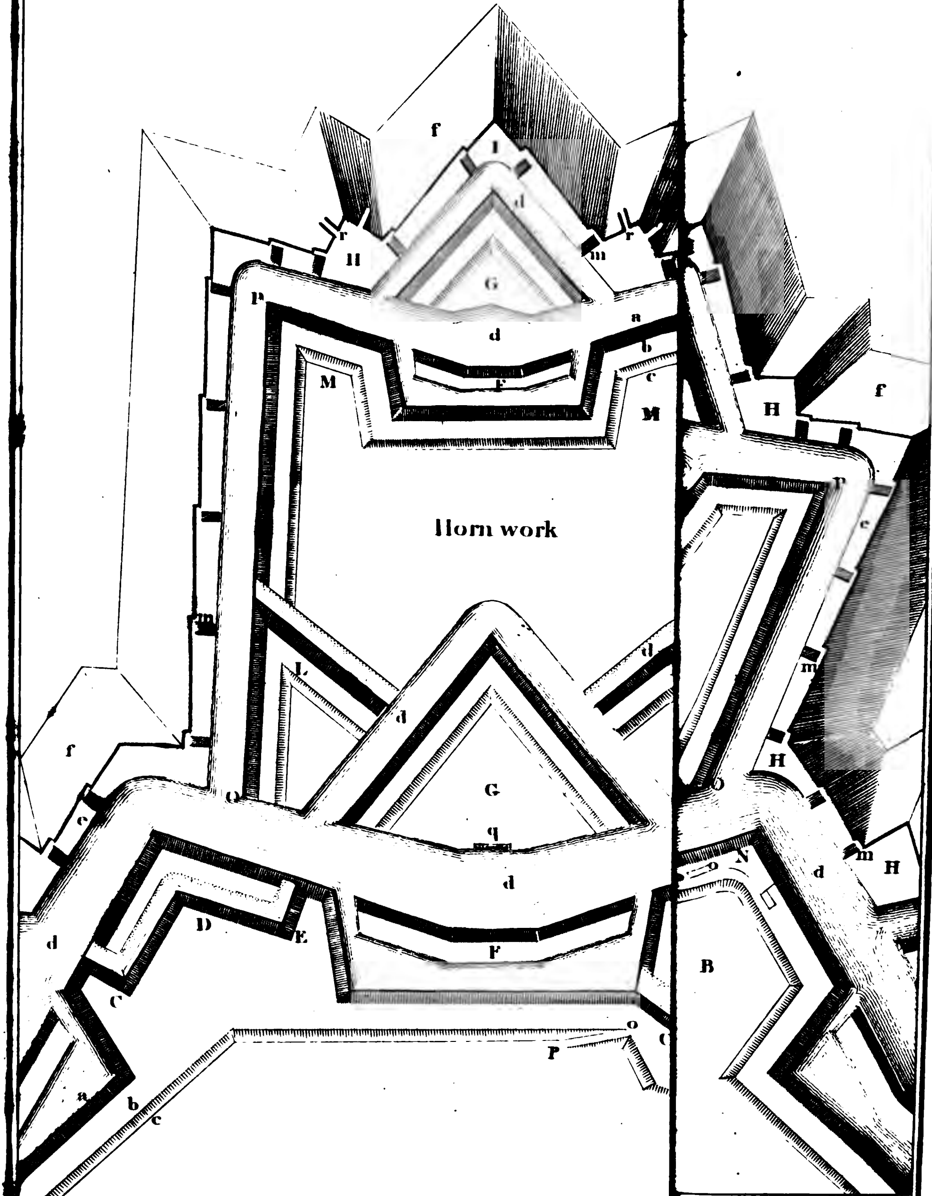
Pl. 2.

Fig. 3.



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Explanation of Fig. 3 and 4, Pl. 2.

A	Full bastion, with orillons and concave flanks.
B	Empty bastion.
C D E	Intrenchment in a full bastion.
F	Tenaille.
G	Ravelin.
K	Intrenchment in the ravelin.
L	Intrenchment in the horn-work.
M	Half bastion, or demi-bastion.
N	Barbet battery.
O P	Branch, wing, or long side of the horn or crown-work.
H	Re-entering place of arms.
I	Salient place of arms.
a c	Rampart.
a	Parapet.
b	Terre-plein.
c	Interior slope.
d	Ditch.
e	Covert-way.
f	Glacis.
m	Traverse in the covert-way.
m n	Branch of the covert-way.
o p	Ramp.
q	Pas-de-souris, or stairs.
r	Sally-port.
s	Orillon.
t	Brisure of the curtain.
v	Reverse of the orillon.
t v	Concave flank.

Explanation of Pl. 3.

A	Cavalier.
B	Cavalier in form of a horse-shoe.
C	Intrenched cavalier.
D	Redoubt in the ravelin.
E E	Lunettes.
F F	Tenaillons.
G G	Intrenchments in the tenaillons.
H	Bonnet.
I	Counterguard.
K	Intrenchment in the re-entering place of arms.
L	Intrenchment in the salient place of arms.
M M	Detachment or advanced lunettes.
N	Arrow, or flêche.
O	Detached redoubt.
Q	Caponniere.
R	Cunette, or cuvette.
S	Traverse, or half caponniere.
T	Batardeau.
a	Second, or advanced ditch.
b	Second, or advanced covert-way.
c e	Communication, or caponniere.
	Ramp.

THE END.

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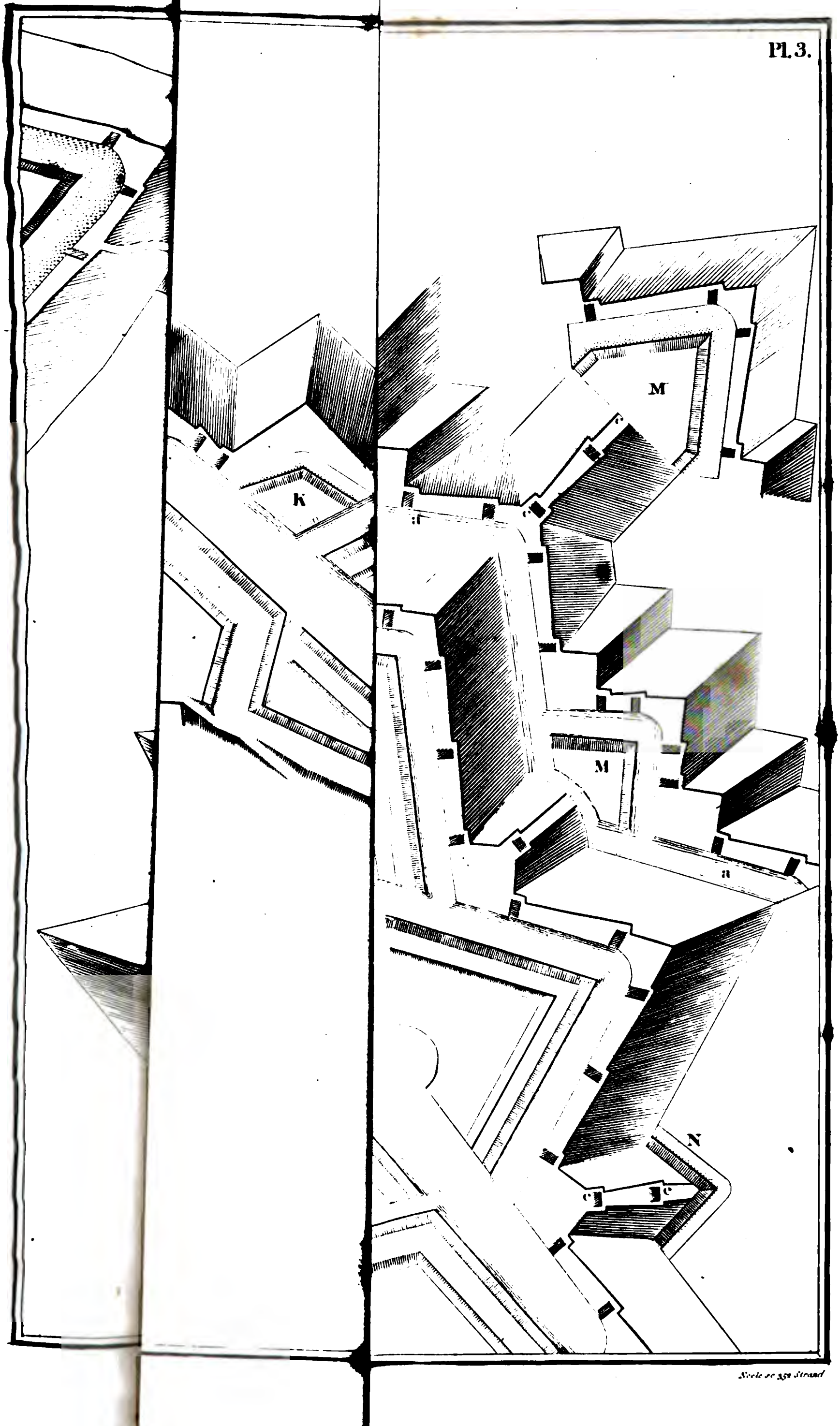
Pl. 3.



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